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EAST

EUROPE

TRANSLATIONS ON EASTERN EUROPE

SCIENTIFIC AFFAIRS

No. 543

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The serial report contains articles concerning the development of and progress in the various theoretical and applied scientific disciplines and technical fields; and the administration, structure, personnel, and research plans of leading East European scientific organizations and institutions, particularly the academies of sciences.

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CONTENTS

DISCUSSION ON LASERS HELD

Sofia NARODNA MLADEZH in Bulgarian 3 Feb 77 p 2

[Article by Yordanka Karamfilova: "Once Again on the Subject of Lasers"]

[Text] Toward the end of last year the second national conference on "Telecommunications '76" was held, with international participation, at the International Scientists House in Varna. It was attended by Bulgarian specialists and scientists working in this field. Also attending as guests and participants were a number of scientists from the USSR, Poland, Czechoslovakia, France, Norway, Italy, FRG, Sweden, and Switzerland. Noted scientists in the field of communications equipment were gathered at this symposium to determine what is being worked at this time, what are the results, what direction will be followed in research and could this be accomplished jointly.

One of the most interesting problems considered at the symposium and already facing world scientists is the development of information transmission technology, bearing in mind that its volume is growing exponentially with the overall growth of the national economy. This fact means that the development of communications equipment should exceed the growth of the national economy as a whole.

In his speech Soviet scientist Kiril Shchelkunov, from the Leningrad Institute of Communications, discussed one of the possible prospects for development of communications equipment--optical systems related to the use of laser beams. The visible spectrum of the optical wave range is located between the infrared and ultraviolet spectrums. It is 50,000 times broader than the currently used radio frequency range which has saturated the air to a considerable degree. Yet, a single ray of light could be used for the transmission of hundreds of thousands of television programs or simultaneous telephone conversations by the population of the entire earth. All this offers possibilities and prerequisites for thinking and working on the practical application of systems in which the laser beam carries the information.

Perhaps no single scientific or technical achievement has gained such rapid recognition or been disseminated so rapidly as the discovery and development

of lasers. Every day we learn of their utilization in a great variety and entirely unexpected areas of science and technology. Their great power and direction of the beam and high spectral density of energy, insuring a dissemination within a very narrow cluster make possible their utilization in communications equipment as well, for tremendous quantities of signals could be transmitted through laser lines both under ground conditions as well as in outer space and at all distances.

However, the crossing of an information beam through rain, snow, fog, and, in general, through heterogenous strata, creates disturbances in the signals, for it is reflected differently for the various frequencies. This limitation in the use of the laser beam raises the question of the creation of a certain protective spatial dissemination environment. For example, using a standard pipe along which the light beam would flow would be very difficult since it has to be placed in a straight position, even if it is located on the ground or on a special support. Inevitably the beam would hit the wall thus creating substantial transmission losses. Experiments have been made in the use of pipes with a reflecting inter surface. Here the light spreads in a variety of internal reflections. Dielectric and gas lenses have been used to carry the beam each of them restoring its condition.

Glass fibers are used in optical transmission systems. They are economically more effective than those now used, for one gram of glass can replace ten kilograms of copper wire. For several years such a telephone system has been used in Moscow, insuring communications between the center of the city and Leninskiye Gory. Optical systems are being installed in the FRG, Japan, and the United States for television and telephone transmissions. Successful experiments in this area indicate that the practical use of lasers for communications may come in the immediate future.

5003
CSO: 2202

AIRCRAFT ACCIDENTS LINKED WITH CERTAIN PSYCHOLOGICAL ASPECTS

Sofia NARODNA ARMIYA in Bulgarian 19 Feb 77 p 2

[Interview with Colonel Dimitur Dimitrov, senior scientific associate and candidate of medical sciences conducted by Captain Engineer Veselin Stoyanov, military pilot first class: "Are the Different Days Colored and How Are We Influenced by the Full Moon?!...."]

[Text] Recently the newspapers ORBITA, OTECHESTVEN FRONT, VECHERNI NOVINI, and others, published articles on problems of biochronometry (the science studying rhythms in living systems) and biometeorology (science on the influence of meteorological factors on living organisms). Accidents and various illnesses are related to the birthday and the "cyclical nature of mental, physical, and emotional activities" which depend on it. The new moon and the full moon are related to the greater frequency of crimes, murders, suicides, and mental disturbances during such periods, and so on.

We could hardly imagine what would happen if before class or training tens of soldiers--drivers, mechanics, pilots, and other military specialists would start extensively talking about so-called "dark days", "weak periods", days of "zero activity", "astrological gaps", and other periods "dangerous" to their life and health during which "one must simply not show up outside"...

Is this really the case? We asked the question to the well-known specialist in flight accident problems Colonel Dimitur Dimitrov, senior scientific associate and candidate of medical sciences.

[Answer] I certainly do not deny the unquestionable achievements of biochronometry and biometeorology particularly in recent years, he said. At the same time, however, I must point out the fascination with, one-sidedness, and over-simplification in the explanation of the mechanism governing the appearance of such complex phenomena such as diseases, accidents, suicides, crime, and so on.

[Question] Could you take as an example transportation and flight accidents?

[Answer] Our studies of the psychophysiological reasons for flight accidents in military and civilian aviation, conducted over a number of years, have

indicated that, on the one hand, a number of external situation factors are of great importance to accidents, such as the method of training, upbringing, organization, management and flight support, aircraft characteristics, and so on; on the other, a number of internal situations exist but in no case do they include the day and month of birth; they apply to the personal characteristics of the flyer: type of temperament, character, emotional stability, flight skills, state of health, and functional condition of physiological systems which insure the continuing adaptation of the body to the various factors of flying, and so on.

[Question] Unquestionably, internal factors related to the personality have a very complex structure. In the final account, however, what is it that determines it?

[Answer] In most general terms, the interaction among three types of "mechanisms": first, inherited behavioral mechanisms (unconditioned reflexes and instincts); second, mechanisms which develop individual adaptation, i.e., the development of individual experience (conditioned reflexes, and first signal connections); third, mechanisms for mastering sociohistorical experience (superior reflexes, and second signal connections).

The first type mechanisms program only the behavior of the person; those of the second and third type program the sociohistorical experience which must be mastered individually. These three types of mechanisms are interrelated. Consequently, the internal reasons for any accident should not be sought separately in some innate qualities but in the overall psychological structure of the personality. Actually, practical experience as well has proved the tremendous significance of individual characteristics and features of communist morality such as conscientiousness, discipline, organization, endurance, willpower, courage, combination of individual with social interest, and so on, in the prevention of accidents.

[Question] What are biological cycles?

[Answer] They represent an internal characteristic of living organisms, including the human body. They appear, are determined, or are influenced by the synchronizing influence of external, rhythmically recurrent factors of the physical cycles of the solar system (related to the earth's rotation around its axis and around the sun, the lunar phases, and others); in this respect they are invariable.

I must point out that attempts to seek reasons for transportation accidents in inherent internal personality characteristics are nothing new to science. They are based on the studies made by Greene Wood, back in 1918, who established individual differences in the occurance of labor accidents. Later on, in 1925, the German psychologist (G. Marbe) transferred this concept to aviation, developing the "theory" of the personality of the accident prone flyer. With certain differences and modifications such theories are being supported today as well by some western authors such as (Z. Geratevol, F. Dunbar, F. Aleksandur, Kh. Khof, P. Berner) and others.

We believe that relating accidents only to inherent internal qualities is very one-sided and, in many respects, unacceptable. The negative aspect of popular writings of this type in which "dark days", "zero activity periods", and others, are substantiated with the help of "scientifically" established facts is that some soldiers may develop a mental condition of predetermination, hesitancy, and a feeling of expectation of something. Yet, everyone knows how complex contemporary combat equipment is and how intensive and important are troop training and exercises, and the concentration and mobilization of efforts they require.

Relating accidents with biocycles, biorhythms, moon phases, and who knows what else belittles and underestimates the implementation of a variety of systematic measures on the part of commanders, political workers, and staffs in the course of their active and purposeful struggle in this direction. Such theorists are harmful from the combat readiness viewpoint as well. Flyers assume their duty, takeoff after the alarm has sounded, and carry out a variety of combat assignments in protecting our socialist homeland not when they wish it but whenever it becomes necessary. The same could be said of soldiers in other specialized areas. We could say something about sportsmen in backing our idea: they are defending the honor of the homeland at many international, olympic, and world competitions without being able to choose the dates of tournaments or take such cycles into consideration. Occasionally, the true sportsman gains victory at the cost of painful and serious accidents and only with a supreme effort of the will...

[Question] Does it seem to you that such "scientific theories" have an emphatically class-oriented nature?

[Answer] Yes, this is the case. This suits greatly capitalist employers. If reasons for accidents are found in the innate characteristics of the individual, in biocycles, biorhythms, and others which could not be influenced, would it be necessary to invest considerable funds to insure the safety of machines, labor safety, and others?

The popularization of such indefensible theories in some of our publications is due to the fact that a serious problem such as transportation accidents is discussed by amateurs insufficiently familiar with transportation psychology. They are unable to analyze a given accident entirely and profoundly in its complex relation with and determination by a variety of external and internal factors. Such authors conduct "studies", and write reports and articles which are most frequently a mixture of erroneous judgements which promote unfinished or erroneously structured statistical elaborations.

Finally, I deem it necessary to emphasize that any author assumes great responsibility to the readers particularly by submitting them as unquestionable untested and unproven scientific facts which could influence the mental condition and create a feeling of uncertainty in many people faced with the implementation of difficult and responsible assignments.

5003
CSO: 2202

ELKA-59 ELECTRONIC CALCULATOR SPECIFICATIONS

Sofia VOENNA TEKHNIKA in Bulgarian No 12, 1976 p 17

[Report: "Our Bulgarian Elka-59"]

[Text] At the 32nd International Plovdiv Fair the Elka-59 Bulgarian electronic calculator received the "Golden Hands" award.

The calculator has programming possibilities and digital buttons. It may be used for the solution of various mathematical, engineering, scientific, and practical problems. It has a floating period. The figures come in a ten-digit mantissa and a two-digit order in the range from 0.1×10^{-99} to $0.9.....9 \times 10^{99}$.

The setting of the operational registers (x, y, w, t) makes possible complex chain computations by punching a minimal number of buttons.

The last processed data may be memorized in an additional register and be read by pressing the buttons LSTx.

The digital memory of the calculator also contains ten free addressed registers. Each of them may have a figure, make possible mathematical operations and the subtraction of the figure they contain.

The calculator may be used for adding, subtracting, multiplying, dividing, raising to various powers, root extraction, determination of the reverse and absolute value of figures, the adding and subtracting of memorized figures, and chain computations. Furthermore, the following functions may be computed: trigonometric, direct and inverse; hyperbolic, direct and inverse; exponential, logarithmic, and factorial.

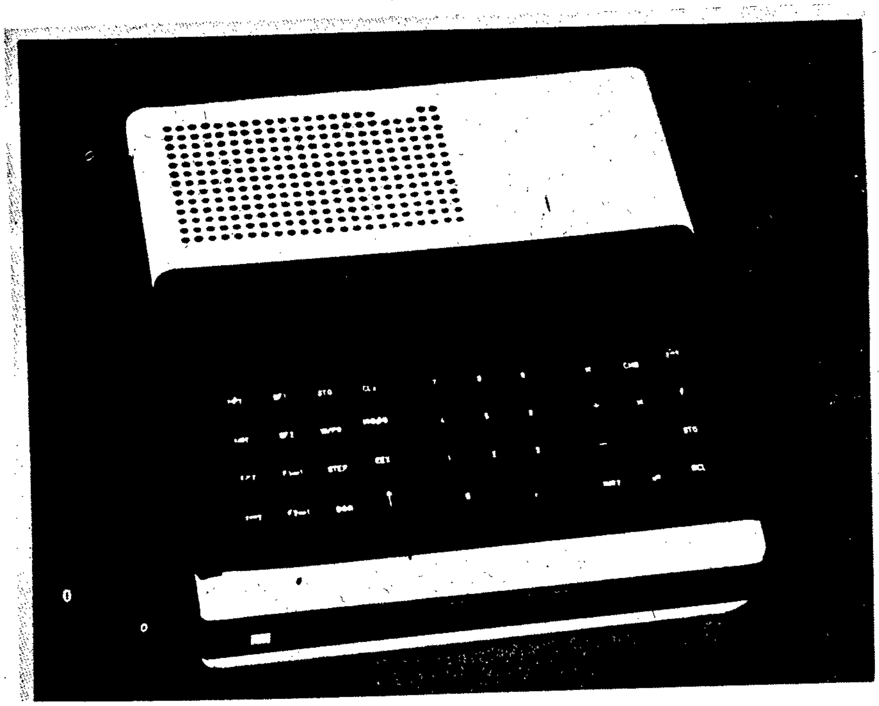
Inverse transformations are possible as well--orthogonal into polar coordinates; degrees and degree fractions into degrees, minutes, and seconds; and degrees into radians.

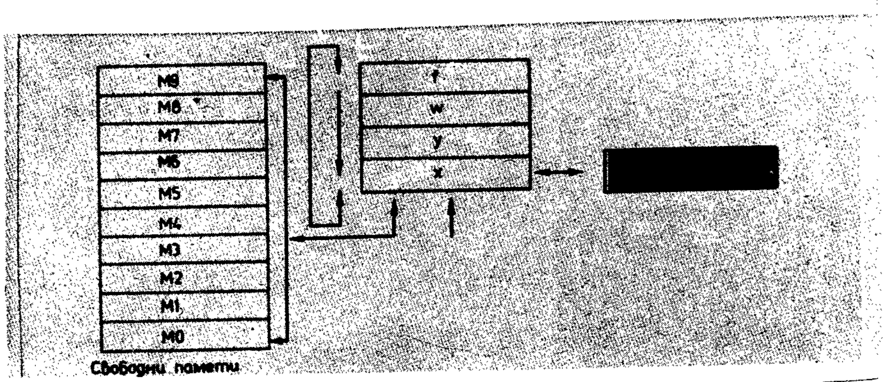
The calculator has a 128 step program memory. With the help of the buttons it could record programs containing unconditional and conditional transfers, conditional transfers based on 13 attributes, cycles, and sub-programs (eight levels of reference to sub-programs).

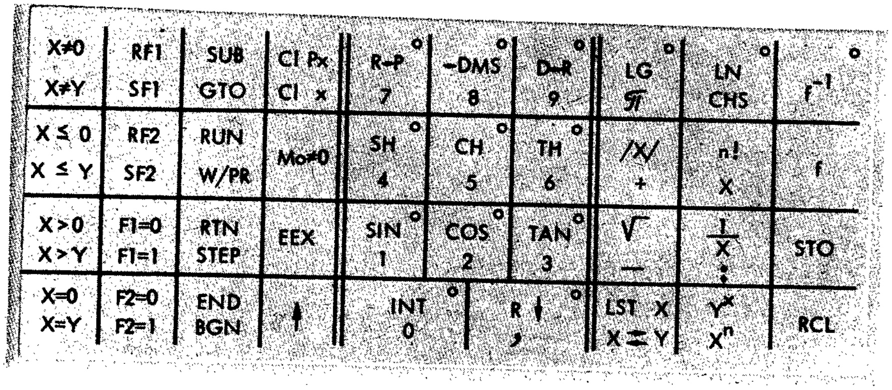
There are 15 digital registers. There are mantissa sign, order, and error indicators.

The calculator consumes a power of 16.5 VA.

Dimensions: 257 x 234 x 82 millimeters; weight--2.4 kilograms.







Drawings: Center--1. Free store; Bottom--Keyboard.

5003
CSO: 2202

BRIEFS

MAGNETIC DISCS ON SOVIET LICENSE--MOM [Hungarian Optical Works] has just completed the first series of magnetic discs produced on the basis of Soviet license. In the past MOM made its discs on the basis of French license. After MOM tested the discs which are made by Sigma in Vilnius, the Soviet and Hungarian partners concluded a license agreement under the terms of which the Soviet enterprise provided the Hungarians with technical documentation and the equipment including starting materials needed for beginning production. MOM makes 400-500 magnetic discs annually. The Soviet license will enable the Works to save 10 million forints in foreign exchange. The completed magnetic disc memories are peripherals which are important units of the R-1010 computer produced by VIDEOTON. [Berlin RECHENTECHNIK DATENVERARBEITUNG in German Feb 77 p 3]

CSO: 2502

USE OF COMPUTERS IN MINING INDUSTRY

Bucharest MINE PETROL GAZE in Romanian No 11-12 (Nov-Dec) 76 pp 497-503

[Article by Dr Gh. Dobra and Dr A. Simionescu: "The Planning System of the Romanian Mining Industry, With Special Emphasis on the Programming of Ore Production Using Computers." Communication to the Ninth International Mining Congress, Dusseldorf, May 1976]

[Text] Introduction

In managing its production activities, a mining exploitation can formulate production plans and programs by considering three alternatives for raw material needs.

1. It can plan production without considering the time element of the user's demand. In this case, the entire planning system is reduced to production planning. This alternative is used when any amount produced can be consumed.

2. It can plan production by considering all the changes in demand on the part of consumers. In this case, along with the production planning subsystem, the planning system also includes a subsystem for the most accurate prediction of demand variations. This alternative starts from the premise that a mining exploitation cannot change its production rapidly, and that it must foresee changes ahead of time.

3. It can attempt to balance demand and production on the basis of an optimization criterion. In this case, the planning system includes the planning of needs, the planning of production, and a correlation criterion for the two plans.

Production planning cannot overlook the demand of consumers, and a mining exploitation cannot change its production from one day to the next without unfavorable economic effects.

In a socialist economy, mining exploitations and consumers of the raw materials which they produce, belong to the unified system of the national economy, a situation which makes it possible to regulate demand and production on the basis of several examinations of the feedback loops which exist among units in the system. Following this planning phase at the level of the national economy as a whole, a mining exploitation can proceed to formulate production plans using available demand figures.

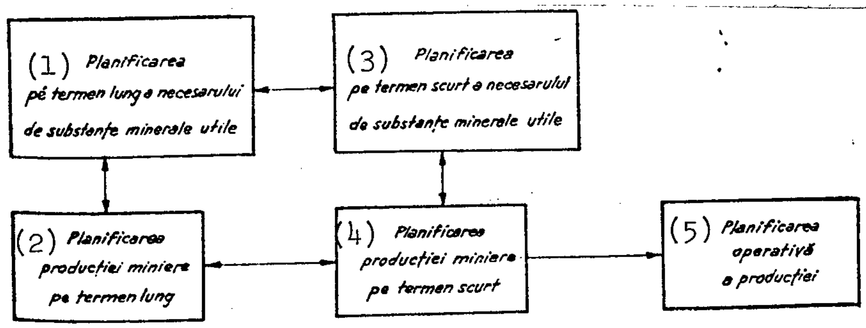


Figure 1. Romania's planning system for mining products.

Key: 1. Long range planning for mineral needs
2. Long range planning for mining production
3. Short term planning for mineral needs
4. Short term planning for mining production
5. Operational production planning

II. Plan Periods

The experience gained with Romania's planned economy has led to the establishment of a planning system which includes long range plans, short term plans, and operational plans or operational production programs (figure 1). Long range plans cover periods of more than one year, and are usually formulated for five years at a time, with even longer range programs being drawn for areas of particular importance. Short term programs are written for one year periods, with quarterly and monthly breakdowns. Operational programs are formulated for the exploitation phase itself, and are used to regulate monthly activities.

Figure 1 shows that the planning system used for mining in Romania operates according to computer principles. The long range planning for raw material needs, factualized by a balanced interconnection among branches, starts with the directives for the country's socioeconomic development and with shorter term forecasts, and generates the first set of control figures for long range mining production planning. After analyzing the available possibilities for meeting the demand, a feedback loop is returned to long range planning for eventual corrections. Once these corrections are made, short term plans and the first control figures are sent out. Using the plans

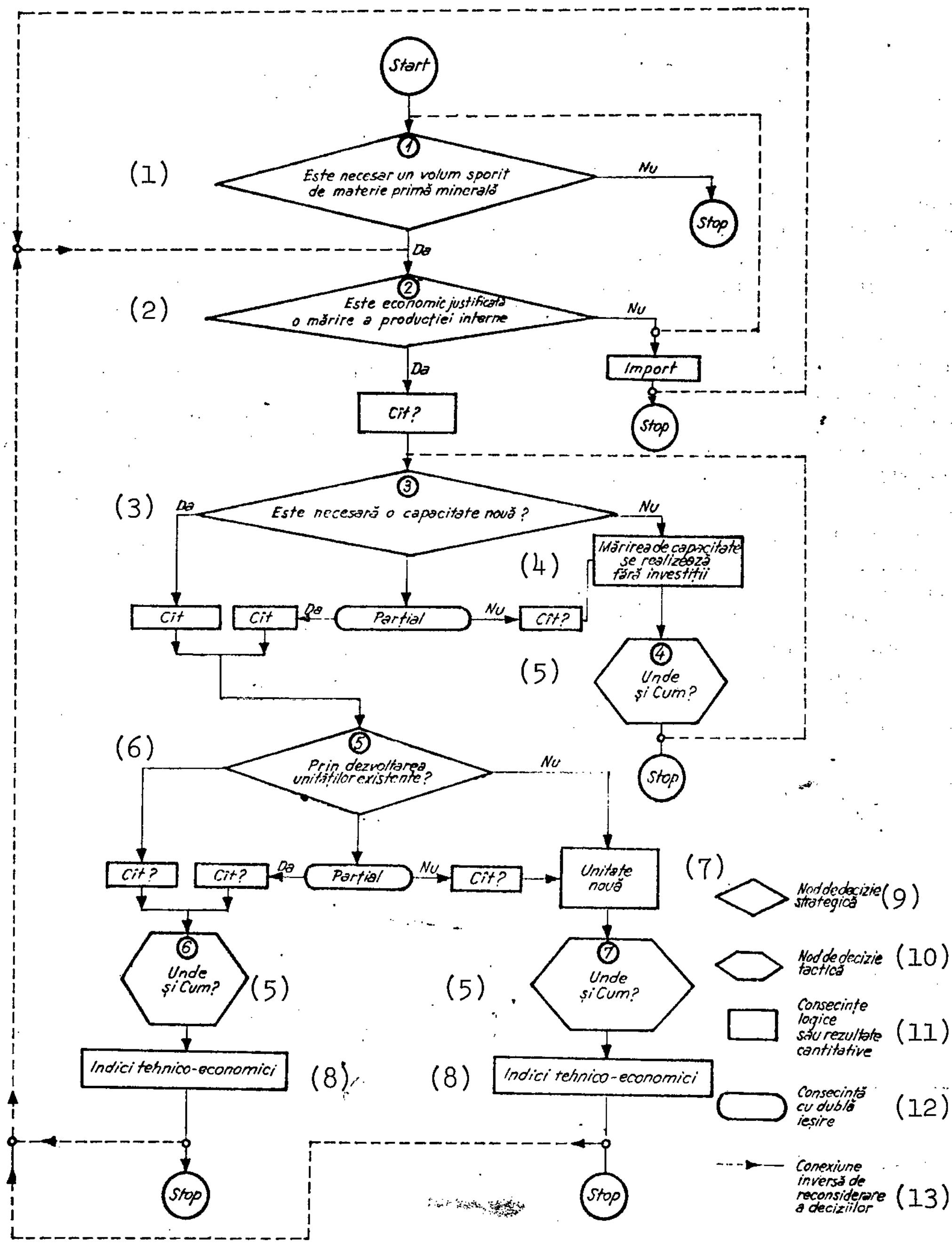


Figure 2. Complete logic path for planning the demand for mineral raw materials.

Key: Da = Yes; Nu = No; Cit = How much

1. Are more mineral raw materials necessary?
2. Is an increase in domestic production economically justified?
3. Is a new capability necessary?

4. The capability can be increased without investments
5. Where and how?
6. Through development of existing units?
7. New unit
8. Technico-economic indicators
9. Strategic decision node
10. Tactical decision node
11. Logical consequences or quantitative results
12. Consequence with two issues
13. Feedback of decision reconsideration

for short term need, corrections are applied to the short term production planning, and by means of feedback loops the long range demand is also corrected as a function of short term production planning. And finally, after the long range production plan-short term needs plan is adjusted, the result is the definitive plan for short term production, which in turn generates the limits of the operational plan.

Each plan category has a specific role according to the period to which it refers. The long range production plan defines the structure of the principal mining operations, while the short term plan specifies the resources, manpower, and costs required to meet the short term demand, fitting within the restrictions of the long range plan. The operational production plan starts with the actual situation of the mining front, and satisfies the goals and restrictions of the short term production plan.

III. Planning for Mineral Raw Material Needs

A complete logic path for planning the mineral raw material demand is shown in figure 2. The feedback system is designed to answer the questions: How much of the need can be met by developing existing mining units? How much by opening new units? And how much by increasing the load of existing units without additional investments for development?

Before determining a figure for the production to be obtained from any one mining unit, an integrated analysis is performed for all the mining units which extract the same useful substance; this provides an intermediate answer for a first round through the logic path, and this answer is then modified by completing the feedback loops.

The system design makes it possible to simulate the production development of a useful mineral substance for any input and for partial or total revisions, as a function of the various assumptions of the problem.

This logic path was reached through an analysis of the experience gained during a quarter century of centralized planning for production units of national significance. In brief, the system has operated starting with the figures provided in the directives for the socioeconomic development of the country, and by asking production units, through their responsible ministries,

to write the first plan proposals, which were then centralized at the State Planning Committee (CSP) as the central planning organization. Depending on circumstances, foundations were established for the figures of the plan and the initial control figures were corrected as a function of known production potentials for all units, and of new demands arising throughout the national economy. The magnitude of the analysis and evaluation projects created by this system did not make it possible to examine various alternatives, nor to complete feedback loops for proper adjustments. But with the transition to automatic data processing using computers, it becomes possible to envisage a closer approximation to the ideal system.

The operation of the system described by the logic path of figure 2 is that of a uniform and rapid procedure for evaluating the production capabilities of units under exploitation, and of a method for formulating documentation for development alternatives in the case of existing exploitations, or for opening new units. The procedure for evaluating production capabilities is part of the subsystem for short term planning and for operational programming, and will be described in the present paper. The method for formulating documentation for development alternatives in the case of existing exploitations, or for opening new units, is applied in technico-economic studies (STE) which are generally formulated for five-year periods, these periods corresponding to the five-year plans for the socioeconomic development of the country. So far, the method for STE formulation has not been finalized to the point where it can be used with automatic data processing, and for this reason the paper will not insist on long range planning. But it should be pointed out that current research and the modules which have already been designed are based on a simulation of the lifetime of the mine [1].

Returning to figure 2, it can be seen that before a production capability is developed through investments, three preliminary questions must first be answered:

Is a larger volume of mineral raw materials necessary?

Is there an economic justification for increasing the production capability?

Is it necessary to create new production units?

The path will normally be followed for an affirmative answer to the first question and for any assumption regarding the necessary increase in volume. The path has a single beginning, namely the start of the problem, and several final outputs, as a function of the results obtained at decision nodes. The decision nodes can have two outputs (Yes or No) (nodes 1 and 2), a partial Yes and a partial No (nodes 3 and 5), and finally, the decision to select between the several alternatives being examined, whose number can be arbitrarily large but no less than two (nodes 4, 6, and 7).

The modules for evaluating development options for mining exploitations are used when the plan alternatives are presented to responsible organs (ministries); these organs integrate then in a linear model with binary variables (0 or 1), to select the optimum alternative which will satisfy the raw material demand, and which will be applied in each mining unit [2]. When formulating the production plan derived from the balance reached at the central organ, the modules are used to develop in detail the adopted alternative.

In the application of the ideas presented above, it was concluded that the basic element of the entire system is the simulation model of the mine's development; this model is conceived in a modular form so that it may be applied to different mines and different alternatives of mine development by means of a combination of several modules.

IV. Production Planning and Programming

The purpose of any planning or programming project for mining activities is to determine the best plan or program option according to a predetermined criterion, while respecting restrictions imposed by the geologic, technical, technologic, economic, and political conditions of the mining unit under consideration.

In a socialist economy, the state also regulates the principal resources which can be used by a mining exploitation (investment funds, manpower, and so on), and the production expenses or cost per unit product. Within these restrictions, the exploitation is asked to produce the maximum value for the national economy. In many cases, this maximum value corresponds to the maximum gross production. But there are cases when a maximum gross production does not correspond to a maximum usefulness to the national economy of the useful substances obtained in the gross mining materials. In particular, this is the case of polymetallic ores. The criterion of maximum usefulness can be applied to the selection of a plan or program alternative in which any amount of ore produced can be consumed, and for which a numerical value of usefulness to the national economy can be established for a unit measurement of the ore.

There are also cases in which the state establishes a fixed amount of ore to be produced, and asks the unit to produce it with minimum expenses or at minimum cost.

Starting with the fact that the selection of an optimization criterion is a decision making problem, which can change from time to time as a function of political, economic, or social circumstances, the production planning subsystem was designed to allow the selection of alternatives according to any simple and complex criterion. The criterion of maximum usefulness, evaluated by means of the ELECTRE [1] method, was adopted for short term plans and programs, and the criterion of "maximum priority" [3] was chosen for long range plans.

The production planning subsytem was designed to satisfy the following points.

1. To integrate into a unified plan the former partial plans for mining exploitation (the geologic exploration plan, the opening operations plan, the cutting operations plan, the manpower plan, the maintenance plan, the plan for materials supply, and so on).

2. To enable an easy and rapid application and modification of data, and a simultaneous application of both long range and short term plans.

3. To assure the scheduling and dispatching of work sites, workers, and equipment, as well as the calculation of planned costs.

Starting with these requirements, work began on the formulation of the main files at the foundation of planning and programming, namely: the reserves file, the mining operations file, the file on principal capabilities, the consumption standards file, and the mine structure file.

Reserves File

The design of the new production planning and programming system sought to correlate geological research and exploitation activities. The subsystem for computer calculation and evaluation of reserves was adapted to the demands of production planning and programming. To this end, the reserves of useful substances were categorized as a function of mining operations [4], with an introduction of reserves management according to "elementary units" of production in the planning and programming system.

The reserves file contains geologic data (reserve quantities, contents, geometric characteristics, and so on) at the level of "elementary units" in the production programming; the "elementary unit" of production depends on the type of deposit and methods of exploitation. Some files are organized according to cutting fields, blocks, and panels.

One module of the programming subsytem, which has yet to be completed but which is being designed now, is intended to simulate several alternatives for dividing reserve zones and their exploitation systems, and to select the optimum alternative. The module will be based on the geological file completed with the data necessary for selecting an exploitation system, and on the file for exploitation technologies, interconnected with one another by a set of compatibility rules and algorithms for evaluating the exploitation results. Technological parameters are currently stipulated by technical personnel, and consist primarily of forecasting mining operations and their characteristics.

Mining Operations File

From a technologic standpoint, an underground exploitation is a combination of cutting fronts or mining operations. Several mining operations combined according to the requirements of an exploitation system provide a first

subsystem of mining exploitation -- the cutting wall, and further combination leads to a group of cutting walls (wing), horizon, or level subsystems, and ultimately to the mine system. The mining operations file includes identification data for any operation, data on geometry (profile, length, volume), and technological data.

Principal Capabilities File

This file contains the date needed to calculate the capabilities of the main means of transportation, wells, principal installations, preparation plants, and so on. The file is updated along with development, modernization, repairs, and other projects.

Consumption Standards File

This file includes standard allocations for manpower and principal materials consumptions, according to techniques used in mining operations, and to the main factors which influence the magnitude of the consumptions (rock characteristics, type of equipment, technical specifications, and so on).

Mine Structure File

The mine structure file represents the central element of the automatic data processing system used to program production. This file establishes precedence relationships among operations in the operations file, and specifies other causes which can stop certain mining operations. This file is composed of the code of mining operations, the code of operations which determines the beginning of a given mining operation, and the amount of work which must be performed for each immediately preceding operation. In addition, it stipulates codified causes for interruption and the duration of interruptions.

The mine structure file provides the data needed to perform a network analysis for programming mining operations.

V. Mathematical Models Used in Production Planning and Programming [5]

Long range planning uses a linear dynamic model in which the variables are the production planned to be extracted from the reserve belonging to an elementary production unit.

Depending on the planning scope, the elementary production unit can be a part or even an entire exploitation block.

The linear dynamic model consists of a system of linear restrictions concerning the satisfaction of metal demand, the capabilities of principal installations, the content limits in supplying plants, relationships between reserve contents and extracted ore, availability of equipment and manpower, and so on. In addition to these restrictions, which are encountered in most works on the problem of production planning in the mining industry, the model also includes

restrictions referring to the order of exploitation. To begin with, by dividing the mine into subsystems it was possible to establish restrictions which follow from system to subsystem, regarding the sequence of exploitation. In this way, when the elementary unit of the model is a section, the sections will be separated as a function of the block or panel to which they belong. When the preparation stage for a block does not allow the exploitation of the first section, all the block sections are excluded from the first stage production program.

The dynamic aspect of the model is created by the performance of the section exploitation sequence after the first section exploitation is ended. In concrete terms, the model starts from the many sections located in blocks or panels, which can be programmed into production. The first linear programming model solved is valid for a period equal to the shortest duration of all the durations of section exploitation. This satisfies part of the plan task corresponding to the amount which will be extracted from the section removed from exploitation. The plan task is reduced accordingly, and the conditions of exploitation are established for the many other sections at the time the first section is terminated, and then the linear model is solved once more until the planning limit is reached.

The criterion function in the dynamic linear model is a sum of priorities. The priority appears as an equivalent of the conventionally constant costs applying to the elementary production unit. As distinct from direct costs, which do not depend on the moment at which a ton from the elementary unit's reserve is included in the exploitation program, the priorites express in a transformed manner the actual costs which depend on the moment at which the ton of reserves is included in the program.

The dynamic linear model gives the period during which a section will be extracted, without exactly stating the dates on which the section will be started or ended, or the succession of mining operations concerning the section.

The production planning system further permits the detailed programming of preparation for the sections which will be exploited as directed by the solution of the linear dynamic model. The preparations program resorts to a critical path analysis model, and establishes the duration, the start, and the end of each mining operation, so that the section will be exploited at the required period.

The operational production plan resorts to a combinatorial model in which the elementary activity is no longer the section, but rather the working wall of the mining project. The rate of work of the mining operation appears as a variable of the model. The rate of work implies the assignment of a standard team at the working wall, for 0, 1, 2, 3, or 4 working shifts. Each mining opeaation (advance or cutting) which fulfills the conditions for being programmed, can be entered into the mine's production program at one of the five rates. One version of the program will include all the walls which can possibly be programmed at one of the five rates. The number of versions

increases very rapidly as the number of operations increases, since it is 5^N (where N is the number of mining operations which can possibly be programmed). A study of all the alternatives is not possible, except in a mine with a reduced number of walls. For mines with a large number of walls, solutions can be generated through heuristic algorithms.

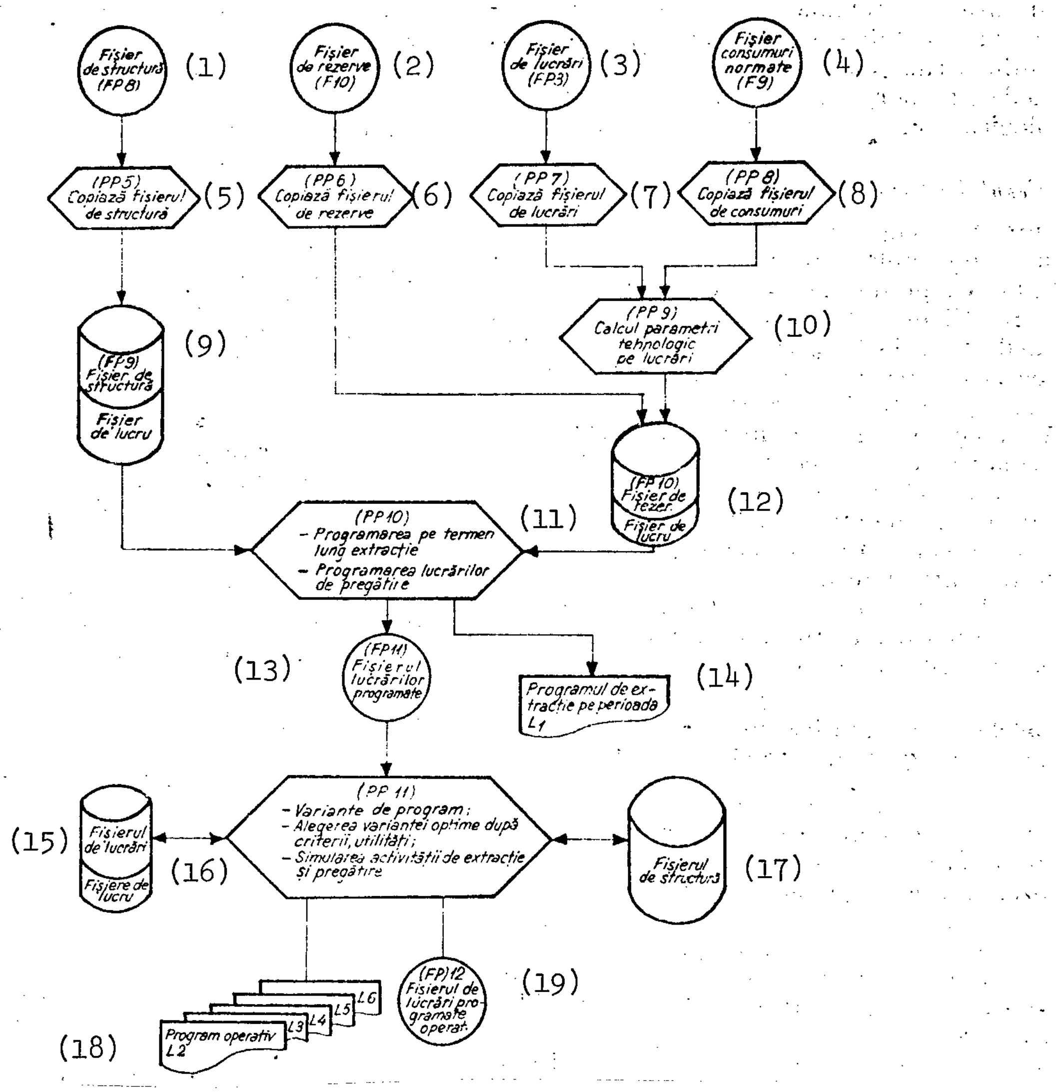


Figure 3. Logic path for production programming system.

Key: 1. Structure file (FP8)
2. Reserves file (F10)
3. Operations file (FP3)
4. Standard consumptions file (F9)
5. Copies the structure file (PP5)

6. Copies the reserves file (PP6)
7. Copies the operations file (PP7)
8. Copies the consumption file (PP8)
9. Structure file (FP9) -- Working file
10. Calculation of technical parameters of operations (PP9)
11. Long range extraction programming -- Programming of preparation operations (PP10)
12. Reserves file (FP10) -- Working file
13. File of programmed operations (FP11)
14. Extraction program for period L1
15. Operations file -- Working file
16. Program versions -- Selection of optimum alternative according to criteria, usefulness -- Simulation of extraction and preparation activities (PP11)
17. Structure file
18. Operational programs (L2, L3, L4, L5, L6)
19. File of programmed operations (FP12)

Ten versions are retained from the solution to the combinatorial model; these are judged best in that they deviate least from the restrictions imposed on the operational plan. The version to be used is selected by means of the ELECTRE method, on the basis of the significance of its deviation from first order restrictions.

The last model of the production planning and programming system enables the simulation of active walls, up to the time the first cutting front ceases its actity. At that time, the combinatorial model is recalled in order to find the most adequate available cutting front as replacement. The combinatorial model does not change the basic solution of fronts which have been operating in the preceding stage, except to the extent to which none of of the fronts available for programming fails to provide a suitable replacement for the terminated front without changes in the rates of active fronts.

After finding the replacement front, the critical path analysis model is used to establish the sequence of preparations for this front, or in other words, to formulate the operational program of preparation operations.

A logic path of the system for automatic data processing in production planning and programming is shown in figure 3. The computer programs are written in COBOL language for the Felix 256 computer. The long range program (PP10) is reviewed annually, and the operational program (PP11) is reviewed monthly.

BIBLIOGRAPHY

[1] Lisovski, A., Czylok, A., and Madejeski, A., "Forecasting an Effectiveness of the Variants of Construction and Development of Coal Mines in the

Long Range Planning Computerized System (the SPP System)," III/17, The Seventh International Mining Congress, Bucharest, Romania, September 4-9, 1972.

[2] Kolar, J., "Development Optimization in a Coal Mining Area," III/14, The Seventh International Mining Congress, Bucharest, Romania, September 4-9, 1972.

[3] Janssen, A. T., "Long-Range Production Planning of Direct-Shipping Ore from Several Deposits," International Symposium of Computer Applications and Operations Research in the Mining Industry, Salt Lake City, Utah, USA, September 17-19, 1969, in A Decade of Digital Computing in the Mineral Industry, edited by Alfred Weiss, AIME, New York, 1969.

[4] Simionescu, A., "Reserves Categories Used in Production Planning and Programming," XXVth Session of the Petrosani Mining Institute, November, 1973.

[5] Lapusca, A., Simionescu, A., and Morar, M., "Ore Production Programming Through Simulation of Actual Advance of Underground Faces," 13th APCOM International Symposium, Clausthal University, West Germany, 6-11 October, 1975.

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ROMANIA

EXPERIENCE IN MINING UNDER DIFFICULT CONDITIONS

Bucharest MINE PETROL GAZE in Romanian No 11-12 (Nov-Dec) 76 pp 491-496

[Article by Prof Bujor Almasan: "On Romania's Experience in Exploiting Deposits With Difficult Geologic Conditions and Low Content of Useful Elements." Paper presented to the Ninth International Mining Congress, Dusseldorf, May 1976]

[Text] Indispensable to economic development, and to human civilization itself, raw materials and energy resources have always formed one of the crucial problems of society, and of nations' economic and commercial policies.

Since the war, specialists, responsible factors, and public opinion have never been more concerned with raw materials and fuels than they have been in recent years. The sometimes dramatic intensification of these concerns is far from being surprising, or from being determined solely by circumstantial factors. It provides a measure of the dimension, complexity, and acute nature of one of the major problems which confronts mankind today -- that of the material resources which it has at its disposal to assure the advancement of the human civilization.

The data of the problem are continuously and powerfully amplified by the profound transformations and changes of our days, which concern the technical, economic, and political (or economico-political) aspects of raw materials, and which affect all the countries of the world.

From a technologic standpoint, the changes and transformations in one direction tend to upgrade the use of existing resources (better exploitation, diversification, substitution of raw materials, continued expansion of the idea of exploitable resources), and in another and more daring direction, promise the creation of new resources, by means of which mankind would be freed from the fear of exhausting reserves with an inevitably limited lifetime, and would succeed in owning resources which are either recyclable or practically inexhaustible.

From an economic standpoint, the demand for raw materials is no longer being met from reserves at the same rate, the world's mineral resources are being exploited irrationally and being used in an exasperatingly ineffective manner, international exchanges are impeded by artificial mechanisms of price stabilization and tarrifs, and so on.

And from a political or economico-political standpoint, the acquisition of raw materials becomes increasingly complicated in the face of a non-uniform distribution of reserves throughout the world and of the maintenance of outdated mechanisms in international relations and exchanges.

Under existing conditions, the problem of raw materials and energy resources has reached an unprecedented complexity, surpassing the power of any science or group of sciences, and of any national or international organization. Solutions at the level of the problem's dimensions demand sustained efforts and daring approaches, involving scientists in natural and social sciences, political and economic decision makers, and international organisms.

A rather significant portion of this huge task falls to us, gathered here for this Ninth International Mining Congress; I will attempt to summarize it as follows:

1) To determine and formulate this problem as accurately as possible, as it is defined by today's and potential circumstances, for one or two periods in the not-too-distant future, in the the light of geological and mining sciences, of the vast experience gained during the history of mining, and of forecasts;

2) To define several directions or orientations for increasing the world's exploitable mineral resources, in order to free the world from what some pessimists have called "the nightmare of raw materials."

I realize that while we cannot accept the conclusions of many pessimist groups, we cannot at the same time neglect or underestimate the circumstances which have aggravated this problem. By the same token, I believe that we must confidently welcome the sometimes fascinating glimpses which advanced sciebtific research is offering us into new sources of energy, sources which promise to become applicable toward the end of this century, as well as into the remarkable progress which is being made in raw material substitutes. But I do believe that we should be concerned with our abilities to provide for an extended period, the huge quantities of metals specified in forecasts and unaffected by substitutes,as well as with being able to meet the demand for energy with existing resources, at least until mankind will be in a position to effectively use the new advances, until they will be available to all. I do not think that our meeting can be satisfied with a presentation of opinions, but rather believe that it must delineate at least a few paths to follow, paths which I have no doubt will offer mankind hope and balance.

In what follows, I will relate part of the experience which Romania has gained in increasing its usable mineral wealth through the exploitation of deposits with relatively difficult geological conditions and of inferior quality, an experience which is limited or even inexistent in the world.

It should be noted that under the conditions of the Romanian economy -- conditions which are to some extent encountered in other countries -- the exploitation of these deposits is far from having negatively affected economic growth or the standard of living; on the contrary, their exploitation has been a significant contribution to economic development. Moreover, no other way would it have been possible to obtain the quantities of raw materials and fuels necessary to support such a rapid growth of the industry and of the entire economy. These deposits will continue to contribute similarly for the next few five-year plans, plans for which forecast studies have already been conducted. And finally, even if the situation were not judged only from a quantitative standpoint, the fact remains that the average cost of primary energy and electric power could be sustained at the same level, and that the cost of non-ferrous metals could be maintained at the level of the world market, even though the deposits were poor and difficult to exploit.

I therefore believe that in the absence of an alternative solution, and in the light of qualitative and quantitative results, Romania's experience, which is firmly anchored in the country's economic policy, is a legitimate source of information.

For a country such as Romania, which at the time of World War II had an underdeveloped economy characterized by an annual extraction (in 1938) of only 4 million tons of solid mineral substances, and by a specific consumption per inhabitant of only 18.2 kg of steel and 72.4 kWh of electric power, and which during the last quarter of a century has made an accelerated effort of industrial development (at an average annual rate of about 13 percent) in order to eliminate its development gap, the problems of raw materials have always been important, and have become increasingly demanding. This, despite the fact that its geological structure has favored the formation of mineral accumulations, and despite the fact that mining facilities have existed on its territory for a long time.

In order to provide the national industrialization with as much protection as possible against dependence on foreign raw materials, Romania's industrial and energy policy has been to rely primarily on our own resources. This has involved large efforts for discovering, inventorying, and exploiting our mineral resources. This path has provided a significant amount of the basic materials for the country's industrialization during the period of the first five-year plans. Due to the rapid growth of the demand, determined by the industrial rate of development, it was not long before many needs remained unfulfilled by the exploitation of solely those deposits whose conditions and qualities were similar to those currently exploited throughout the world. Given the alternatives of importation, or of exploiting deposits with difficult geological conditions or poor in useful elements, we selected the latter solution on the basis of studies conducted for that purpose.

I. Energy

The industrialization and electrification plans stipulated that energy needs would increase at an annual rate of 9 percent for primary energy, and of 15 percent for electric and thermal power, rates which were confirmed by the country's economic growth during the last quarter century.

The energy policy was initially based on this sustained demand and on a domestic position for various energy carriers , which was characterized by:

Limited reserves of crude oil and natural gases;
A similarly limited usable potential for rivers;
A high proportion of coal in the total reserves of mineral fuels;
And a significant amount (about 70 percent) of inferior coal in coal reserves.

The energy policy was thus oriented toward the fullest utilization of the river potential, the highest possible development of coal production, in particular of lignite, and the moderate development of hydrocarbon extraction; in addition, it allocated as many of the hydrocarbons as possible to industry, to be used as raw materials. This orientation was firmly maintained, and even stressed, after 1970, even though in the meantime coal production in many countries reached a ceiling, and in some cases was reduced, with the economies of these countries being massively converted to petroleum. Examples of this policy are the limitation, and ultimate cessation, of construction of electric power plants which burn hydrocarbons, and the conversion of hydrocarbon burning plants to lignite consumption.

1. The quality of Romania's lignite deposits is much lower than that of the deposits exploited in the majority of lignite-producing countries (the two Germanies, Czechoslovakia, Russia, Poland, and USA). Only Bulgaria and Greece extract lignite of similar quality. The lignite reserves in the Oltenia region (which contains 90 percent of the country's total reserves), for instance, contain 34-40 percent ash, have a humidity of 39-45 percent, and provide a thermal power of less than 1700 kcal/kg for surface extraction, and 1900 kcal/kg for underground extraction. Young deposits (Dacian, Levantine) are difficult to exploit. They are usually located in clayey, marly, and sandy soils. The surrounding rocks have poorer and lower physical and mechanical characteristics (cohesion of 2-5.7 tf/m^2, and friction angles of 4-12^o) than the lignite veins. The exploitable lignite strata, with thicknesses of 1-8 m, usually occur in bunches interspersed with sterile material, and have aquifer formations in their immediate vicinities. Eight horizons of aquifer sands are located above the deposit, in the exploitable coal bulk, and in the coal stratum. The aquifer horizons in the stratum contain water at a pressure of 10 atmospheres, presenting the danger of eruption. Hydrostatic pressures (or hydrodynamic ones, when the aquifer sands are not drained) reach high values, up to 50 meters water column, and sometimes very high values, 50-130 meters water column. Although the aquifer sands can be drained, they have a low filtration coefficient. Vast drainage projects are being conducted according to various schemes in all deposits under exploitation.

Because the exploitable deposits are shallow (up to 180 meters), nearly 70 percent of them are exploited at the surface, but significant quantities are still being taken from underground. The open pit exploitations have capacities of 1-8 million tons per year, depths of 30-50 meters in the lowlands and 150-180 meters in the hills, and uncovering coefficients of 1-7 m^3/ton. The exploitation technology is a continuous process one, and the sites are provided with excavators, transporters, and other equipment which is equal to that available throughout the world.

The underground mines have capacities of 1-1.5 million tons per year, and are opened with galleries and slopes cut into the coal; the extraction is conducted with longwall techniques (80-100 meters), and with mechanized cutting and transportation, and the supports are metallic. Following extensive experiments, mechanized supporting was introduced in more than 50 percent of the cuttings. In 1974, these cuttings obtained average daily advances of 2.35 meters, achieving performances of 8.5 meters/day.

Difficulties are still encountered in the exploitation of thick strata (between 4 and 7 meters), which are usually extracted in two slices (horizontal) under an artificial ceiling.

The lignite extracted in the Oltenia region is used exclusively for burning in large capacity (3-6 sets of 330 MW each) thermoelectric plants located in the coal basins.

The extraction of lignite has increased steadily, and will continue to grow during the next two five-year plans, as shown below:

		Total extracted coal	Lignite
1938	Thousand tons	2,826	273
	Percent of total	--	9.7
1975	Thousand tons	32,190	22,677
	Percent of total	--	70.4
	1975/1938 growth	11.4 times	83 times
1985	Thousand tons (estimated)	75,920	59,890
	Percent of total (estimated)	--	78.7

2. In recent years, a deposit of bituminous shale was discovered in the Southwest of the country, with an industrial reserve which so far has been established to be about 500 million tons. The deposit has a thickness of 20-100 meters, slopes of 50-60°, limestone and carsts in its covering, voids left by old coal exploitations in the stratum, and many tectonic accidents. The qualitative characteristics of the shale are: thermal power lower than 1000 kcal/kg, 4 percent shale oil, 23-25 percent Al_2O_3, and 7-12 percent Fe_2O_3. After burning, the ash contains as much as 30 percent Al_2O_3, 15 percent Fe_2O_3, and more than 50 percent SiO_2.

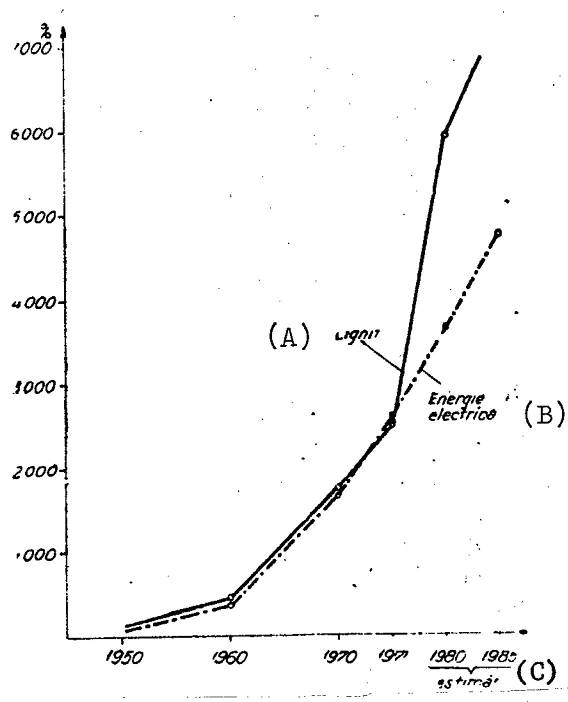

Figure 1. Electric power and lignite production in Romania (kWh and tons).

Key: (A) Lignite
(B) Electric power
(C) Estimated

The first stage plans provide for the deposit to be utilized by burning in a thermoelectric plant with a power of 990 MW.

The exploitation of 12.5 million tons per year will be conducted in a quarry, at a depth limited to 200 meters and an uncovering ratio of 1.5 m^3/ton.

The basic problem in building the thermoelectric plant has been in designing a type of boiler which would burn this fuel under favorable technical and economic conditions.

Research is being conducted for the comprehensive utilization of the deposit of bituminous shale, so as to obtain an iron concentrate, alumina, shale oil, and many applications for ashes; this research is being carried out in collaboration with foreign organizations.

3. Deposits of cokeable coal with a lower reserve potential are also being exploited in the Southwest region of the country. The exploitation is faced with extremely difficult conditions created by strong tectonization, thin (frequently 0.6-1 meter) and very slanted (40-70°) strata, heavy methane

emanations (50 m^3 per extracted ton), unusual depths (more than 1050 meters), and so on. What is more, the extracted coal has a high ash content (up to 35 percent) which is intimately mixed with the coal mass, resulting in low quantitative extractions of cokeable coal (45 percent maximum). Given the superior coking properties of this coal, its exploitation will be continued and even developed on the basis of new geological explorations.

4. One of our experiences is the large scale utilization in coke fabrication, of poorly cokeable or even uncokeable coal produced in Valea Jiului.

This involves the fabrication by fluidization, of semicoke from type 611 coal, and its use as degreaser in the manufacture of coke, using about 50 percent of gas coal with poor and intermediate coking properties. Subsequently, it became possible to obtain briquette coke from non-agglutinated coal, for ovens, foundries, and other applications. This coke was able to replace traditional coke in 700 m^3 furnaces, at an equivalency of 1:1.2 and in a proportion of 30-33 percent of the coke charge. In coming years, all the type 611-633 coal from this basin, washed to about 8.5 percent ash, will be used to manufacture coke. As a result, the proportion of coal used to manufacture coke is continuously growing, as shown in the following table:

	1950	1975	1980 (estimate)
Total washed bituminous coal, thousand tons	2,104	6,402	9,390
For coke and semi-coke	65	1,845	5,250
Percent	3.1	29.8	56

II. Metallic Ores and Nonmetallic Substances

By following the economic policy indicated here, the special efforts which have been made in geologic activities have led to a continuous growth of reserves of the A + B + C_1 category, for all solid mineral substances. On 1 January 1974 as compared to 1 January 1951, these reserves had increased by 2.7 times for iron ores, 8.3 times for bauxite, and 62 times for nonferrous ores, the greatest increase being recorded for copper bearing ores.

1. Iron Ores

Overall, the iron ore deposits which are exploited in Romania have a low reserve potential, low iron content (24-35 percent), and a high silica content (up to 21 percent). The principal deposits at Poiana Rusca are exploited at a depth of 450-700 meters under excessive pressure conditions. In order to be used in furnaces at an acceptable productivity and with a low coke consumption, the iron ores are prepared through a magnetizing roasting and magnetic separation (siderite ores), obtaining a concentrate of 52 percent Fe with a silica reduction to 6-8 percent, for a metallic extraction of 85 percent.

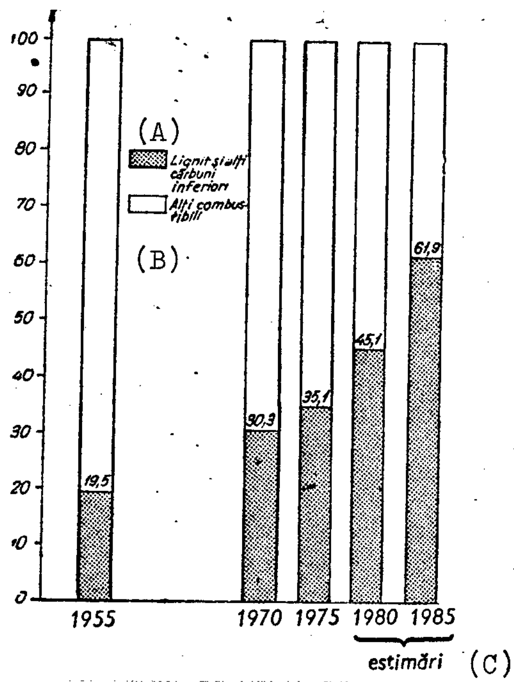

Figure 2. Production of thermoelectric power as a function of fuel.

Key: (A) Lignite and other inferior coals
(B) Other fuels
(C) Estimated

In 1962, a deposit of oolitic limonite containing 24-26 percent Fe, was opened near Cluj-Napoca at Valea Capusului. The exploitation is conducted in a quarry, where the ore is subjected to a complex preparation process consisting of washing-desintegration, grinding, classification, desludging, inverse flotation, and wet magnetic separation in a strong field. The end product is a concentrate with 40 percent Fe and a 78-80 percent metal extraction.

Under study is the exploitation of the Palazul Mare deposit of 600 million tons with an average content of 25 percent Fe, at a depth of 800-1200 meters, and very difficult hydrogeologic conditions, involving the existence in the calcaro-dolomitic deposits of Jurasic age in the cover, of a strong aquifer with a specific flow of up to 2000 m^3/h for a level change of only 1 meter. The exploitation of this deposit was considered in the light of price rises for iron ores on the world market, of the progress which mining technology has made in opening deposits located in zones with difficult hydrogeologic and geologic conditions, and of the results obtained in concentrating poor iron ores. The research has shown that this deposit could produce concentrates with 50-64 percent Fe, and with extraction yields of 67-70 percent.

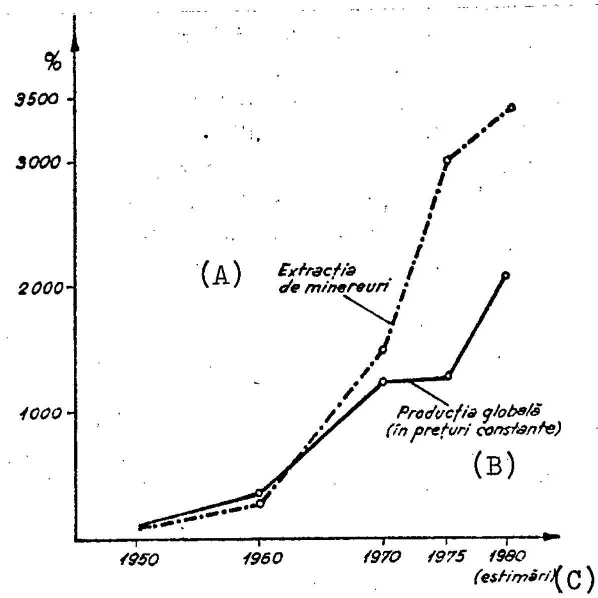

Figure 3. Total mining production in the nonferrous sector, and total extraction of nonferrous ores.

Key: (A) Ore extraction
(B) Total production (in constant prices)
(C) Estimated

2. Nonferrous Ores

Most of the deposits exploited in Romania have a reduced potential, thin veins, high dispersion, a metal content generally lower than that of other exploitations throughout the world, and in some cases present difficult preparation conditions because of their chemical and mineral compositions.

One example of the interest for increasing the recovery of metals from ores which are difficult to prepare, and implicitly of the interest for making it possible to process the concentrates in existing metallurgical installations, is that of the deposit of complex and finely interspersed ores at Lesul Ursului. This type of ore is composed primarily of pyrite (frequently more than 40 percent) and quartz, with variable contents of galena, calcopyrite, and blende, very closely ingrown with the pyrite and the quartz (under 30 microns). The technology which is being used, and which is called selective-collective flotation, leads to the following concentrates which can be processed in existing metallurgical installations:

A 14 percent Cu concentrate with a recovery of 64 percent Cu;
A joint Pb and Zn concentrate with 8 percent Pb and 29 percent Zn;
And a pyrite concentrate with 74 percent S.

Intensive research and design work is being conducted to exploit two deposits of poor copper ore (0.25-0.35 percent Cu), a deposit of siliceous bauxite, and some alluvial sands with low contents of titanium and zirconium. In addition, some small deposits will be exploited together with the preparation of the ore in mobile installations.

We will examine here the two deposits of poor quality copper deposits.

2.1 The deposit of copper-bearing Banatites at Moldova Noua, in the Southwest of the country, formed of a Banatitic eruptive body composed of intensely fissured granodioritic porphyries, with mineralizations of pyrites, calcopyrites, molybdenum, and entirely subordinated blende and galena, has a high reserve potential but an average content (after considering quantitative and qualitative dilution) of 0.23 percent Cu, 3.2 percent S, and 0.0043 percent Mo.

The shape and space distribution of the deposit have suggested a quarry exploitation, with steps of 20 meters, a depth of up to 430 meters, a three-shift operation, an uncovering ratio of 1.4-2 tons of sterile per ton of useful material, and a mathematical dimensioning of 9.0 million tons per year. The economic criterion for optimization has been a minimum cost (equal to that for the exploitation of richer deposits). The preparation technology of collective-selective flotation with regrinding of the collective concentrate will achieve the exploitation of all the useful elements (Cu, S, Mo) in three concentrates (copper, pyrite, and molybdenum), with a recovery of 84 percent for Cu, 80 percent for S, and 70 percent for Mo.

2.2 The deposit of copper-bearing Andesites at Rosia Poieni (Apuseni Mountains), located in an isolated area, with a rugged terrain at an altitude of 960-1300 meters, has a mineralization in the form of impregnations and especially bands; its copper minerals are calcopyrite, bornite, and enargite, accompanied by magnetite, molybdenum, and germanium. The reserve volume is rather significant, but the contents are poor (0.26-0.36 percent Cu, about 2 percent S, 58-69 g/t Mo, and 0.97-1.44 percent magnetic Fe).

As in the preceding case, the deposit lends itself to being exploited as a quarry in its upper portion, with a large capacity of 15 million tons per year. The production capability was established according to the criteria of deposit geometry, front line and capability of equipment, minimum cost, possibility of reaching capabilities, and degree of reserve assurance. The uncovering ratio is 1.4 tons of sterile/useful materials.

The preparation technology is based on differential flotation, regrinding, secondary flotation, thickening, and filtration; for a supply with a Cu content of 0.26-0.30 percent, it leads to a concentrate containing 14 percent Cu, 28.5 percent S, and 28 percent Fe, with an extraction yield of 70-75 percent Cu.

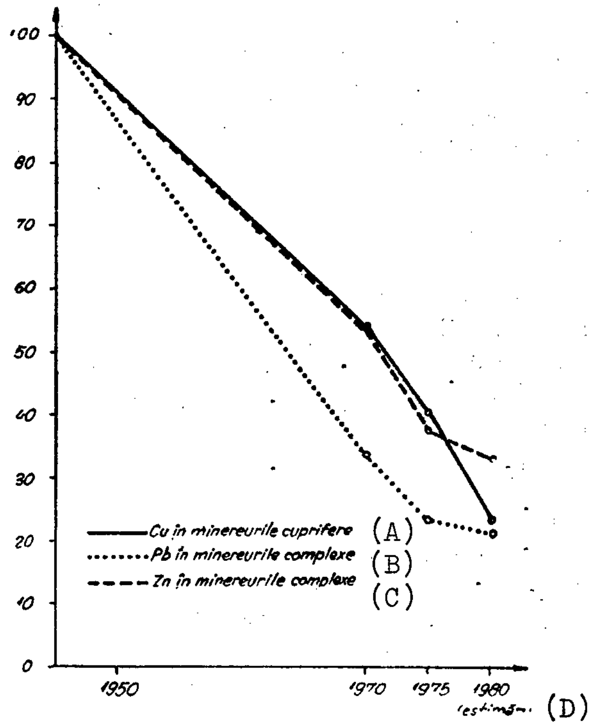

Figure 4. Metal content of nonferrous ores.

Key: (A) Cu in copper-bearing ores
(B) Pb in complex ores
(C) Zn in complex ores
(D) Estimated

As deposits with increasingly smaller contents are introduced in exploitation, the quantities of extracted ores have increased appreciably, together with a concomitent decrease in the average content of supply ores, as shown in figures 3 and 4.

3. Nonmetallic Substances

One deposit only will be used as an example: the deposit of sulfur rocks in Muntii Calimani, in the Northeast of the country, located at an altitude of 1700 meters, where the sulfur occurs finely impregnated in a quartz mass, at a content of 18-22 percent S, and 70-75 percent silica. The quarry exploitation does not create any difficulties beyond those resulting from the altitude. Taking into consideration the characteristics indicated above, difficulties have arisen in the complexities of mechanical preparation and chemical processing, leading to appeals for foreign collaboration.

The technology adopted has been one in which the flotation is achieved at a less advanced granulation, and in which a chemical technique of autoclaving the floated concentrate (with about 60 percent S) was introduced between the flotation and melting operations, producing a granulated technical sulfur with 95-96 percent S. The production capability of the unit is set at 920,000 tons of ore per year.

In all the cases described here, the technical solutions were almost entirely provided by Romanian researchers, and the projects were totally formulated in Romania.

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